Saskatchewan
Agriculture, Food
and Rural
Revitalization

ADF

AGRICULTURE DEVELOPMENT FUND

FINAL REPORT

20010223

DEVELOPMENT OF COST-EFFECTIVE FUNGICIDE APPLICATION STRATEGIES FOR THE CONTROL OF ASCOCHYTA BLIGHT IN CHICKPEA

Funded by: The Agriculture Development Fund

March, 2005
Prepared by: University of Saskatchewan

105-04365/

Development of cost-effective fungicides application strategies for the control of ascochyta blight in chickpea

Final Report
Project: 20010223
Res.: 57AD
February 2005

Cheryl Armstrong-Cho[1], Sabine Banniza[1], Godfrey Chongo[2], Yantai Gan[3], Tom Wolf[4]

[1] CDC, Department of Plant Sciences, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK S7N 5A8
[2] Present address: Bayer Crop Science, 410 Downey Road, Saskatoon SK S7N 4N1
[3] AAFC - Semiarid Prairie Agricultural Research Centre, Swift Current, SK S9H 3X2
[4] AAFC - Saskatoon Research Centre, 107 Science Place, Saskatoon SK S7N 0X2

a) Abstract

Field experiments were conducted to determine optimum application timing and most efficacious rotation and combination of fungicides to control *Ascochyta rabiei* causing ascochyta blight in chickpeas (kabuli and desi chickpea varieties at several locations). Highest disease levels and, in some cases, the lowest yields were observed in treatments that had no pre-flower application of a fungicide. Early control of the disease at the pre-flower stage, regardless of follow-up applications, was significant under the range of disease pressures observed during the course of the study.

Dithane at a low concentration at pre-flower followed by Bravo at early flower and Quadris or Headline at late flower resulted in high disease levels and low yields Dithane at a low rate lead to high seed infection levels under high disease pressure, and was not as effective as using Dithane at a high rate or in combination with Headline under moderate to high disease pressure.

b) Executive Summary

Ascochyta blight is a major limiting factor in chickpea production in Saskatchewan and reduces both yield and quality of chickpea when conditions are conducive for disease development. A critical factor in ascochyta blight management is the timely application of fungicides. Prior to 2003, only Bravo was registered for the control of ascochyta blight in chickpea. Quadris and Headline became available for use in the 2003 crop season, and Lance in 2004, thus widening the choice for producers. Trials were conducted at Saskatoon, Swift Current and in producer's fields at various locations in Saskatchewan to determine the optimum application times and the most efficacious combination and/or mixture of different fungicides.

Two field experiments were conducted, each using cultivars of both seed types, desi and kabuli. Trials at Elrose and Zealandia in 2002, and at Swift Current, Dinsmore and Demaine in 2003 suffered from drought and disease severity was below 10% in the untreated checks. Temperatures were normal and several rain events throughout the season allowed the disease to develop to moderate (20-50% in control plots) at Saskatoon in 2003. Despite cool conditions during the spring and late summer, disease levels in 2004 were moderate in desis, and high (over 50% in control plots) in kabulis at Saskatoon, Swift Current and Kyle.

Experiment 1 examined the efficacy of different application timings, and experiment 2 evaluated different fungicide sequences. Experiment 1 compared single, double and triple applications of Bravo, and rotations of Headline with Bravo or with Lance applied at pre-, early, mid-, late flower and/or at podding. Results clearly indicated that a pre-flower application of either Bravo or Headline had a significant effect on reducing disease severity over a wide range of disease pressures. Applying Bravo or Headline later, at early flowering, resulted in significantly more disease that was comparable to disease severity levels observed in untreated check plots. In some cases, treatments with pre-flower application of fungicide had 20-30% higher yields than treatments where applications commenced at early flower.

In the second experiment, most of the treatments used resulted in lower disease severity compared to the untreated check. Exceptions were those treatments that had a pre-flower application with Dithane at the lower concentration, followed by Bravo at early flowering and a strobilurin at late flowering. Calendar spray with Dithane resulted

in comparable plant protection compared to other treatments under moderate disease pressure, but at the low rate of Dithane, high seed infection resulted under high disease pressure.

Results of these experiments show that applications of fungicides at the pre-flower stage were critical to the control of ascochyta blight in chickpea. The timing and product used in subsequent applications was of lesser importance, but these additional applications were necessary for effective disease management. Three applications of fungicide were often more effective than two applications at reducing disease levels and increasing yield. The inclusion of two strobilurin applications in the sequence of products used had a significant effect on reducing disease levels at moderate disease pressure, and on reducing disease and seed infection at high disease pressure.

c) Technical Report

Background:

After an increase of chickpea acreage to 1.1 million acres in 2001, chickpea production has decreased significantly over the past 2 years. One major contributing factor to this decrease is the persistence of ascochyta blight caused by *Ascochyta rabiei* that can cause yield losses in excess of 90% in Saskatchewan. Wide distribution of inoculum contributes to these high crop losses, and the relatively wet growing seasons in 1999 and 2000 caused inoculum levels to greatly increase. In addition, a shift of the fungal population to more aggressive isolates (Vail et al., 2004) has made disease management even more challenging. Some resistance in chickpea varieties to ascochyta blight is available, but at present, disease management is dependent on timely and efficient use of fungicides. Although some research on fungicide application in chickpea was done previously at AAFC, an increased knowledge into the biology of the fungus and the registration of new products required a re-evaluation of strategies for the most efficient use of fungicides. This study was funded by the Saskatchewan Agricultural Development Fund with support from the Saskatchewan Pulse Growers Association, Syngenta Crop Protection Inc., BASF Canada Inc. and Dow Agro-Sciences. When the study was initiated, only Bravo 500 was registered on chickpea, and Quadris had emergency registration. Through collaboration with the agri-chemical industry, new fungicide products Quadris, Headline and Lance are now fully registered, and have been incorporated into this study to provide farmers with the most up-to-date information.

Project Objectives:

a) To investigate the effect of fungicide application timing on disease control (including pre- and post-flower application),
b) To investigate the effect of fungicide sequences and tank mixes on disease control,
c) To compare prophylactic per calendar fungicide application versus application based on field scouting.

Materials and Methods:

Experiment 1: Fungicide Timing

Fungicide trials were conducted at Saskatoon (Kernen Research Farm, University of Saskatchewan) and in commercial fields located in Saskatchewan from 2002 to 2004.

Cultivars Myles (desi) and CDC Yuma (kabuli) were used at Saskatoon in all years. Commercial fields were located near Elrose (Myles) and Zealandia (CDC Chico) in 2002, near Dinsmore (Myles) and Demaine (Amit) in 2003, and near Kyle (Myles, Sanford) in 2004.

The fungicides used included Bravo 500 (chlorothalonil, Syngenta), Quadris (azoxystrobin, Syngenta), Headline (pyraclostrobin, BASF) and Lance (boscalid, BASF) (Table 1). For several treatments, additional fungicide applications or product substitutions were incorporated into the design in 2003. In treatment 8, an additional Headline application was added at early flower, and an additional Bravo application was added at late flower. Treatment 9 featured an additional Bravo application at podding. The Bravo applications at podding in treatment 11 and at late flower in treatment 12 were replaced with applications of Lance. The Lance applications at pre-flower and podding in treatment 14 were replaced with Headline applications. The treatment design was a randomized complete block design (RCBD) with four replicates.

Fungicides were applied in 200 L ha^{-1} spray volume at 275 kPa using standard flat fan nozzles. Disease severity was assessed using a 0-11 scale at five spots in each plot at each fungicide application and 10-14 days after the last fungicide treatment. Plant density was determined about 4 weeks after seeding. Yield, one thousand seed weight and percent seed infection were also determined. Plots established in commercial fields at Elrose and Zealandia in 2002 and at Dinsmore and Demaine in 2003 were not harvested due to severe drought conditions and lack of disease, and are therefore not discussed. Plots of Myles established in a commercial field at Kyle in 2004 were also not harvested because they were mistakenly harvested by the producer when harvesting the rest of the field.

Chickpea seed infection was determined on 40 seeds per plot by surface sterilizing the seed, plating it onto tap water agar in Petri dishes and incubating the plates for 1 to 2 weeks. Disease incidence on chickpea seed was evaluated by counting the number of seeds with infection by *A. rabiei*.

Data from Saskatoon in 2002 could not be used due to contamination during spaying and poor emergence (from a cool spring), low pod fill and poor yield as result of cool wet weather at the end of the season.

Table 1. Fungicide treatments (trt) used in Experiment 1 to evaluate different timings of fungicide application.

	Growth stage				
	Pre-Flower	**Early Flower**	**Mid- Flower**	**Late-Flower**	**Podding**
Trt	(~ 7 days before first flower	10-14 days after last application	10-14 days after last application	10-14 days after last application	10-14 days after last application
1	Check				
2	Bravo				
3	Bravo		Bravo 500		
4	Bravo			Bravo 500	
5		Bravo 500	Bravo 500		Bravo 500
6	Bravo	Bravo 500		Bravo 500	
7	Bravo		Bravo 500		Bravo 500
8	Headline	Headline (2003-2004)		Bravo 500 (2003-2004)	
9	Headline		Headline		Bravo 500 (2003-2004)
10	Headline			Headline	
11		Headline	Headline		Lance (Bravo in 2002)
12	Headline	Headline		Lance (Bravo in 2002)	
13	Headline		Headline		Lance
14	Headline (Lance in 2002)		Lance		Headline (Lance in 2002)

Fungicides: Bravo 1kg ai/ha; **Headline** 100 g ai/ha; **Lance** 300 g ai/ha.

Experiment 2: Fungicide Sequencing

Fungicide trials were conducted at Saskatoon (Kernen Research Farm, University of Saskatchewan) and at Swift Current (AAFC-SPARC) from 2002 to 2004. Cultivars CDC Yuma (kabuli) and Myles (desi) were used. Fungicides included Dithane (mancozeb, Dow-Agro Sciences) applied at a low and a high rate, Bravo 500, Quadris, Headline and Lance. The treatments included various sequences of fungicides as well as a Bravo 500 plus Quadris tank-mix treatment (Table 2). At Saskatoon an RCBD with four replicates was used for each cultivar. A split-block design with cultivar as main-plots and fungicides as sub-plot factors was used at Swift Current.

Fungicide application, disease rating and harvest data collection were conducted as described above. Disease severity was very low (<10%) in 2003 on both cultivars at Swift Current due to severe drought conditions. Data from Saskatoon in 2002 could not be used due to contamination during spaying and poor emergence (from a cool spring), low pod fill and poor yield as result of cool wet weather at the end of the season.

Table 2. Fungicide treatments (trt) used in Experiment 2 to evaluate different fungicide rotations.

	Growth Stage				
	Seedling	**Pre-Flower**	**Early Flower**	**Mid-late Flower**	**Podding**
Trt	~4 weeks after seeding	10-14 days after last application	10-14 days after last application	10-14 days after last application	10-14 days after last application
1	Check				
2		Bravo		Quadris	
3		Bravo		Headline	
4		Bravo/Quadris*		Bravo/Quadris*	
5		Dithane - L	Bravo		Quadris
6		Dithane - L	Bravo		Headline
7		Bravo	Headline	Headline	Bravo
8		Bravo	Quadris	Quadris	Bravo
9	Dithane – L	Dithane - L	Dithane - L	Dithane – L	Dithane – L
10	Dithane – H	Dithane - H	Dithane - H	Dithane – H	Dithane – H
11	Dithane – L	Dithane - L	Headline	Headline	Dithane – H
12		Dithane - H	Headline	Dithane – H	Dithane – H
13		Headline	Headline	Dithane – H	Dithane – H
14		Headline	Dithane - H	Headline	Dithane – H
15		Headline	Headline	Lance	Lance

Fungicides: Dithane L = 1.68 kg ai/ha, H = 2.44 kg ai/ha; **Bravo** 1 kg ai/ha; **Quadris** 125 g ai/ha; **Headline** 100 g ai/ha; **Lance** 300 g ai/ha. *Tank-mix.

Statistical Analysis

Disease severity at each rating date was plotted against time and the area under the disease progress curve (AUDPC) was calculated. Because the period of rating varied slightly between experiments, AUDPC was divided by the number of days during which disease data was collected in each experiment, resulting in the average area under the disease progress curve per day (AUDPC / day). Disease data was transformed by exponential transformation prior to analysis to stabilize variance. Disease and yield data were analyzed using the GLM procedure in SAS version 8.2 and means were separated using Tukey's test statistics. Linear contrasts were used to compare specific treatments (considered significantly different when $P<0.05$). Data from different site-years and cultivars could not be combined due to heterogeneity of variance, and in some cases, different treatment or experimental design. Results from each site-year and cultivar will therefore be discussed separately.

Results and Discussion:

Experiment 1: Fungicide Timing

2002 Season

Severe drought conditions prevailed in central Saskatchewan in 2002, and field trials established in producer fields near Elrose and Zealandia had restricted crop and disease development. Ascochyta blight severity had reached 33% in unsprayed (control) plots of cv. Myles by the second rating, but disease severity had decreased to only 12% in control plots by the end of the season due to dry conditions. All of the fungicide treatments were equivalent to each other, but treatments 6, 7, 12 and 13 reduced disease

severity relative to the control. These treatments all had a pre-flower application and either an early or mid-flower application of Bravo or Headline. Remaining treatments did not differ from the control (Fig. 1). Linear contrasts revealed that treatments with three applications were more effective at reducing disease than two applications (P=0.013). In addition, treatments with a pre-flower application were more effective than those where the first application was made at early flower (P=0.04). This also held true for treatments using only Bravo; Treatment 5 (no pre-flower application) was less effective than Treatments 6 (P=0.03) and 7 (P=0.016), both of which had a pre-flower application of Bravo.

Disease severity was very low on cv. CDC Chico (3% in control plots) throughout the season at Zealandia, so no effect of fungicide application was observed (not shown). Plots of both cultivars were not harvested due to stunting, low pod fill, and premature plant death caused by drought.

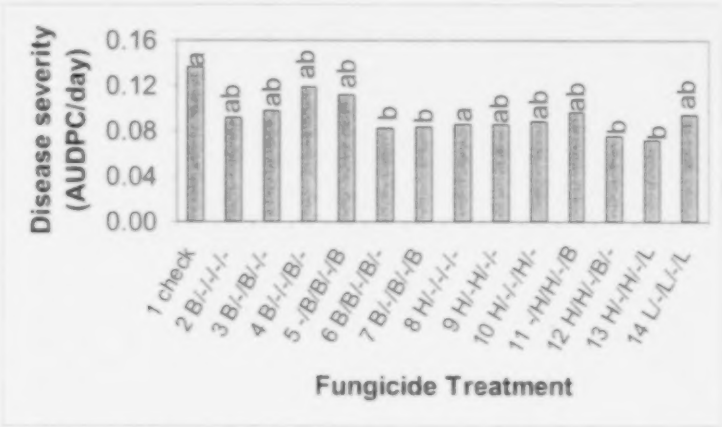

Figure 1. Ascochyta blight severity in 2002 field plots of Myles (desi) chickpea at Elrose to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different.

2003 Season

Field plots in producers' fields were affected by drought again in 2003. Disease severity on Myles at Dinsmore only reached 5% in control plots. Disease levels in the fungicide treatments did not differ from the control (Fig. 2). Despite the low disease pressure and low variability, linear contrasts were able to show similar trends as observed in 2002. Treatments with a pre-flower application were more effective than those without, regardless of the products used (Bravo only, or Headline/Lance combination, P<0.0001). Low levels of disease developed in Amit plots at Demaine, but no symptoms were evident by the end of the season (not shown). As in 2002, plots were not harvested due to very low pod fill caused by severe drought conditions.

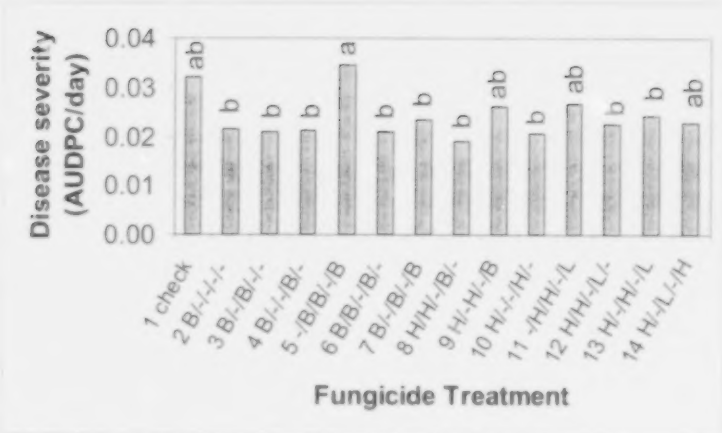

Figure 2. Ascochyta blight severity in 2003 field plots of Myles (desi) chickpea at Dinsmore to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different.

Moderate levels of disease severity developed in field plots at Saskatoon in 2003, with 21% disease in control plots of Myles and 44 % in CDC Yuma.

In plots of Myles, the highest levels of ascochyta blight infection were observed in the control and Treatment 5 plots (early- and mid-flower, podding applications of Bravo). Very little variation was observed among the remaining treatments. Plots that received two early Headline applications (pre- and early flower, Treatments 8 and 12) were superior to treatments without a pre-flower application (Treatments 5 and 11) (Fig. 3). Linear contrasts supported these observations, showing that treatments with a pre-flower application were superior to those without, regardless of the products used ($P < 0.0001$).

Significant yield improvement was not observed for most fungicide treatments on Myles. Treatments 2, 3 and 12, however, increased yield by 30 to 40% relative to the control. Treatment 5, which lacked a pre-flower application, had a significantly lower yield than many other fungicide treatments (Fig. 3). Contrasts showed that treatments with two applications had lower yields than those with three applications ($P=0.026$). As shown previously, treatments without a pre-flower application had lower yields than those with a pre-flower application ($P<0.0001$). Very little variation was observed for thousand seed weight of Myles, and none of the fungicide treatments differed significantly from the control. Although Treatments 2 and 12 were among the highest yielding, the seed weight from Treatment 2 was significantly lower than that from Treatment 12 (not shown). Seed infection levels were extremely low in 2003, with only 1% infection present in the control (not shown).

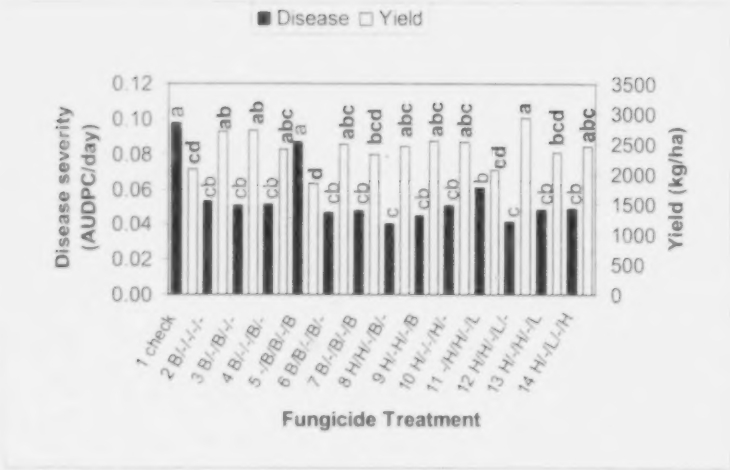

Figure 3. Ascochyta blight severity and yield of 2003 field plots of Myles (desi) chickpea at Saskatoon to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

The results observed in plots of CDC Yuma were very similar to those in Myles, with the control and Treatment 5 plots having the highest disease severity. Plots that were sprayed with Headline at early and mid flower plus an application of Lance at podding (Treatment 11) had similar levels of disease as Treatment 5 plots. All other treatments reduced disease severity relative to the control, but were not different from each other (Figure 4). As for Myles, two applications in CDC Yuma were less effective than three applications (P=0.005), and an application at pre-flower was important for disease control (P<0.0001). In addition, treatments using Headline in combination with Bravo were more effective than those using Headline with Lance (P=0.026).

Yields were generally lower for plots of CDC Yuma than for Myles, so differences among fungicide treatments were not as apparent. Treatment 12 (pre- and early flower application with Headline, late flower application with Lance) was the only treatment to increase yield relative to the control, a 32% increase. This treatment was superior to Treatment 5, where no pre-flower application was made (Fig. 4). Contrasts showed that treatments with a pre-flower application had higher yields than those without (P=0.0002). There was no variation in seed weights for CDC Yuma, and seed infection levels (4% in control) were not reduced by fungicide application (not shown).

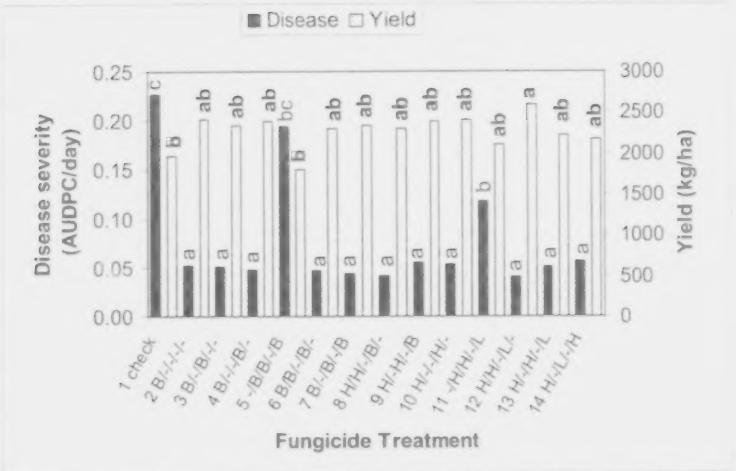

Figure 4. Ascochyta blight severity and yield of 2003 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

2004 Season

The 2004 growing season was characterized by a wet spring, cool weather throughout most of the summer, and early frost. Disease was slow to develop due to cool conditions, but the regular occurrence of small showers allowed disease levels to increase late in the season.

Moderate disease levels (28% in controls) were observed in Myles plots established in producer fields near Kyle. Fungicide treatments 2, 3, 5 and 7 were unable to reduce disease development relative to the control. These treatments utilized Bravo at various times, and all lacked an application either at pre- or early flower. Treatment 4 also shared these characteristics, but was able to significantly reduce disease relative to the control. Little variation was observed among fungicide treatments, but some treatments with a pre-flower and early or mid-flower applications of Headline (Treatments 8, 9,10) had lower disease severity than Treatments 2 and 5. Treatment 2 consisted only of one fungicide application (Bravo at pre-flower), and Treatment 5 lacked a pre-flower application, which may explain the lower efficacy of these treatments (Fig. 5). This was supported by linear contrasts, which demonstrated that overall, treatments with a pre-flower application were more effective than those without (P=0.02). Treatment 5 (Bravo at early and mid-flower) was inferior to Treatment 6 (Bravo at pre-, early-flower, podding, P=0.01), but was equivalent to Treatment 7 (Bravo at pre-, mid-flower, podding, P=0.40). Yield and seed quality data for Myles is not available, because the producer harvested the plots.

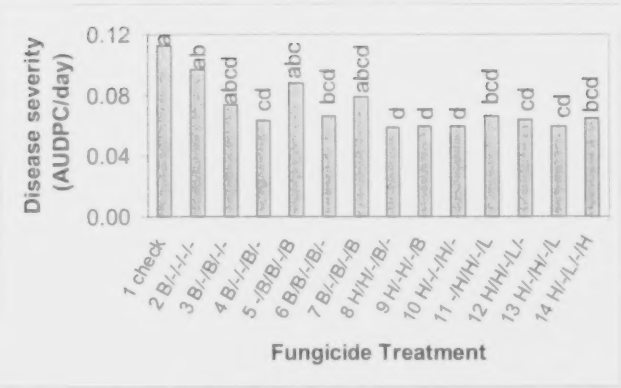

Figure 5. Ascochyta blight severity in 2004 field plots of Myles (desi) chickpea at Kyle to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different.

Very high disease levels developed in plots of Sanford at Kyle, with 99% disease observed in control plots. All of the fungicide treatments reduced disease levels relative to the control. Treatments with a single Bravo application (Treatment 2), no pre-flower Bravo application (Treatment 5), or lacking an early and mid-flower application (Treatment 4) gave poor disease control. These treatments were inferior to treatments with a Headline application at pre-flower, Headline at early or mid-flower, and an additional late-season fungicide application (Treatments 8, 9, 12, 13, 14). Treatments 2, 4 and 5 were also inferior to Treatment 3 for disease control, even though Treatment 3 only consists of two Bravo applications, one at pre-flower and one at mid-flower (Fig. 6). Contrasts supported these observations, showing that three applications were more effective than two applications (P=0.001), and that pre-flower application of fungicide was important for disease control (P<0.0001). In addition, treatments with two applications of Headline during the season were more effective than those that had two or three applications of other products (P=0.02).

Yield of Sanford at Kyle was generally very low, and did not vary much among fungicide treatments. By significantly reducing disease severity, Treatment 3 increased yield by almost 10-fold relative to the control, as did Treatments 12 (10-fold) and 14 (14-fold). Treatment 14, the only one with a Lance application at mid-flower, had a higher yield than treatments with only one or two fungicide applications (2, 4, 5 and 10), and Treatment 6 (Bravo at pre-, early, and late-flower) (Fig. 6). Treatments using Headline and Bravo had higher yields than those using Headline and Lance, as shown by linear contrasts (P=0.04).

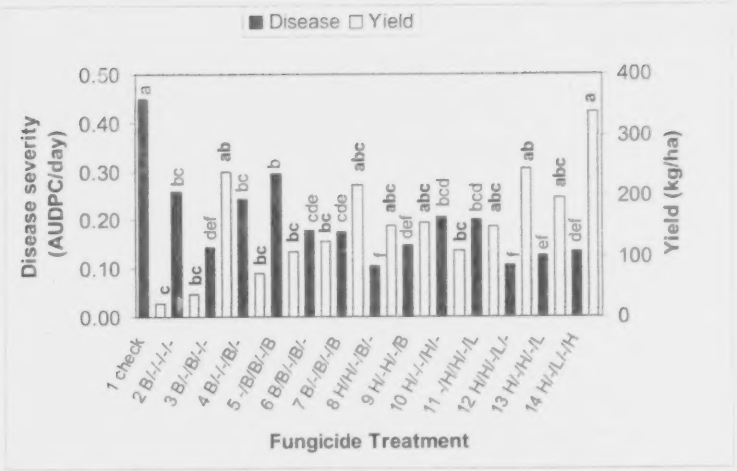

Figure 6. Ascochyta blight severity and yield of 2004 field plots of Sanford (kabuli) chickpea at Kyle to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

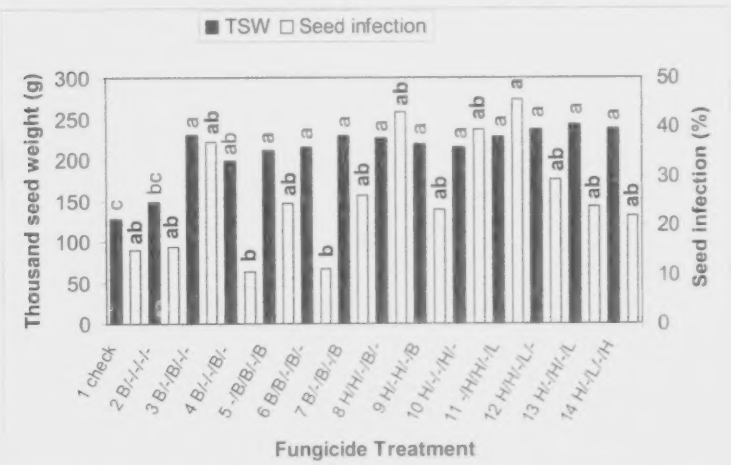

Figure 7. Seed weight and ascochyta infection of seed from 2004 field plots of Sanford (kabuli) chickpea at Kyle to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

In terms of Sanford seed quality, all fungicide treatments increased thousand seed weight relative to the control, with the exception of Treatment 2. The single Bravo application used in Treatment 2 was not sufficient to protect the seed quality under the high disease pressure experienced in 2004. Seed infection levels were quite variable, ranging from 11% to 46%. Consistent trends within this variation were not apparent, and there were no significant differences in seed infection among fungicide treatments, nor relative to the control (Fig. 7).

Moderate disease pressure (41% severity in controls) was observed in Saskatoon plots of Myles in 2004. All fungicide treatments reduced disease severity except Treatment 2 (single application of Bravo). Treatment 12 (Headline at pre- and early flower, Lance at late-flower) gave better disease control than Treatments 4, 5, and 7 (two or three applications of Bravo; Treatment 5 without a pre-flower application). Similarly, Treatment 14 (Headline at pre-flower, Lance at mid-flower, Headline at podding) was superior to Treatments 5 and 7 (Fig 8). Linear contrasts showed that three applications reduced disease development more than two applications (P=0.04). Under the conditions in this trial, treatments with a pre-flower application and those without had equivalent levels of disease (P=0.055).

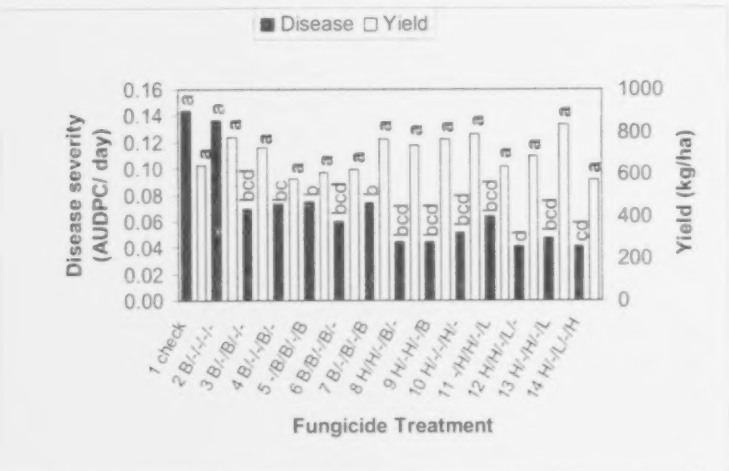

Figure 8. Ascochyta blight severity and yield of 2004 field plots of Myles (desi) chickpea at Saskatoon to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Many plots at Saskatoon were still green when the first frost occurred, resulting in low yields of poor quality. These conditions made the effect of fungicide treatments on

yield difficult to detect, since differences in disease levels resulted in maturity differences. Plots with low disease levels were damaged by frost before achieving their yield potential, whereas plots with high disease levels had reached physiological maturity prior to the frost.

Fungicide treatments had no effect on Myles yield or seed weight in this trial. Seed infection levels were high, with 84% infection in control plots. Treatments 6, 8, 9, 11, 12, 13 and 14 reduced seed infection relative to the control and to Treatment 2 (single Bravo application) (Fig. 9). The effectiveness of Treatment 6 may be due to Bravo applications at pre-flower and early-flower, and the other treatments to Headline or Lance applications at early or mid-flower, or both.

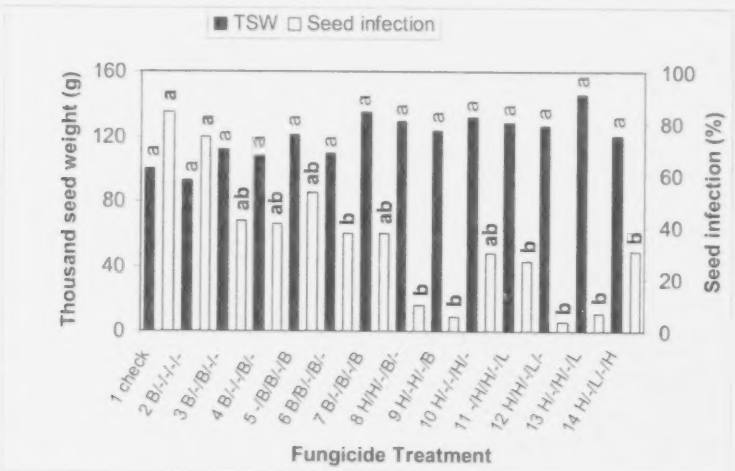

Figure 9. Seed weight and ascochyta infection of seed from 2004 field plots of Myles (desi) chickpea at Saskatoon to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Disease pressure on CDC Yuma at Saskatoon was high in 2004, with disease reaching 88% in control plots. Treatments 2, 4 and 5, consisting of one or two Bravo applications, were unable to reduce disease levels relative to the control. Treatment 3, however, only had Bravo applied at pre- and mid-flower, but reduced disease severity relative to the control. Treatment 8, consisting of Headline applications at pre- and early flower and Bravo at late flower, gave better disease control than treatments using only Bravo (1, 2 or 3 applications), treatments with only two applications of Headline (Treatment 10; pre- and mid-flower), and treatments with no pre-flower application of Headline (Treatment 11) (Fig. 10). Under the high disease pressure in this trial, pre-flower applications were important for controlling disease (P=0.003), and three applications of fungicide were more effective than two applications (P=0.0002).

Yields of CDC Yuma were low, due to cool fall conditions and an early frost, discussed above. Only one of the fungicide treatments increased yield relative to the control. Yields of Treatment 8 (see above) and Treatment 13 (Headline at pre- and mid-flower, Lance at podding) were 125-134% higher than that of Treatment 4, in which no fungicide applications were made at early and mid-flower (Fig. 10). Contrasts showed that treatments that received three applications of fungicide yielded higher than those sprayed twice (P=0.02). The improved disease control achieved by spraying at pre-flower did not result in higher yields than treatments without a pre-flower application (P=0.1).

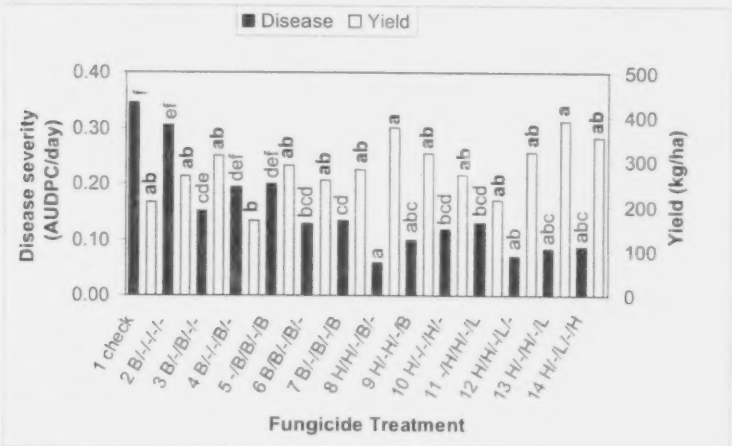

Figure 10. Ascochyta blight severity and yield of 2004 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type

Seed quality of CDC Yuma from Saskatoon was poor in 2004. Treatments 9 and 12 had greater seed weights than the control. Several treatments utilizing Headline (Treatments 9-12) had higher seed weights than Treatment 2 (single application of Bravo). Seed infection levels reached 58% in the control, and all fungicide treatments reduced seed infection levels except for Treatments 2, 3, and 7 (one, two or three Bravo applications) (Fig. 11).

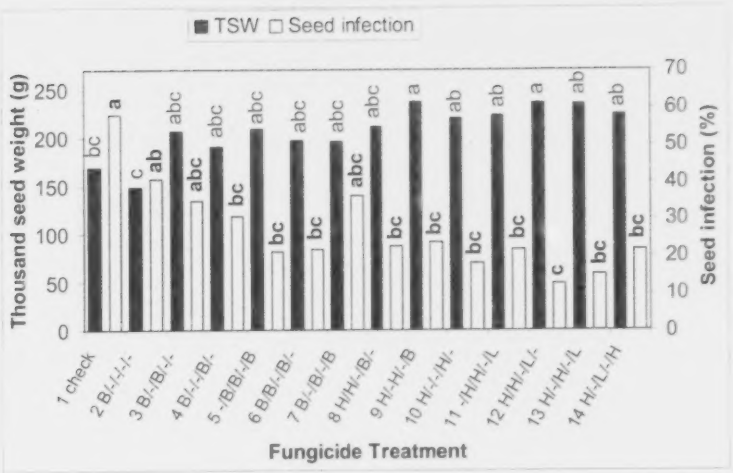

Figure 11. Seed weight and ascochyta infection of seed from 2004 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different timings of fungicide application at pre-/early/mid/late flower/podding with Bravo (B), Headline (H) and Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Experiment 2: Fungicide Sequencing

2002 Season

In contrast to the drought conditions in much of the rest of the province, Swift Current received above average precipitation in 2002. Cool, wet weather in June and again at the end of the season resulted in high disease and seed infection levels.

At Swift Current, disease severity reached 82% in control plots of Myles, and all fungicide treatments reduced disease severity relative to the control. Treatments that had four applications in total, of which two or more were Headline (treatments 7, 13, 14, and 15), reduced disease development more than treatments with only two or three applications and fewer than two Headline applications (treatments 2, 4, 5, and 6). Despite high disease pressure, fungicide treatments did not improve yield relative to the control (Fig. 12). Contrasts, however, revealed that Treatment 9 (five applications of Dithane at low rate) had higher disease levels (P=0.005) and lower yield (P=0.006) than treatments using Dithane at high rate or Dithane in combination with Headline (Treatments 10, 11). Seed infection of Myles reached 35% in control plots. All treatments reduced seed infection except for Treatment 5, consisting of a pre-flower Dithane application (low rate), Bravo at early flower, and Quadris at late flower (Fig. 13).

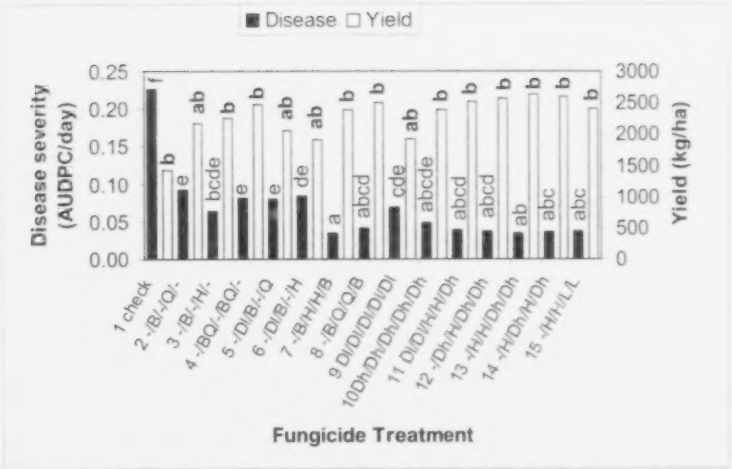

Figure 12. Ascochyta blight severity and yield of 2002 field plots of Myles (desi) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

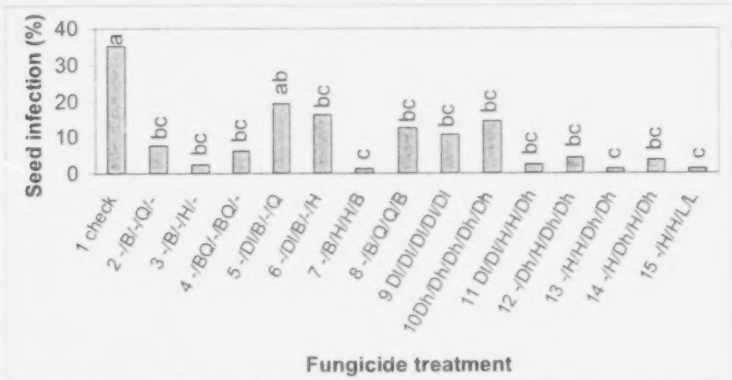

Figure 13. Ascochyta seed infection from 2002 field plots of Myles (desi) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different.

In plots of CDC Yuma at Swift Current, disease severity reached 97% in control plots in 2002. The only treatments unable to reduce disease severity relative to the control were Treatments 2 (Bravo at pre-flower, Quadris at mid-flower), 5 (Dithane-low rate at

pre-flower, Bravo at early flower, Quadris at late flower), and 6 (Dithane-low rate at pre-flower, Bravo at early flower, Headline at late flower). Due to the inability of treatments 5 and 6 to reduce disease development, these treatments also did not result in a yield increase relative to the control. Treatments with two Headline applications gave superior disease control to treatments with one Headline application (Fig. 14). Linear contrasts showed that disease levels were higher and yields were lower when two applications were made than when three or more applications were made ($P<0.0001$). Contrasts also showed that using Dithane at the low rate was less effective at preventing disease and improving yield than using Dithane at a high rate, or using Dithane in combination with Headline ($P<0.0001$). Using Dithane in combination with Headline resulted in lower disease and higher yields than using Dithane alone at the high rate ($P<0.0001$).

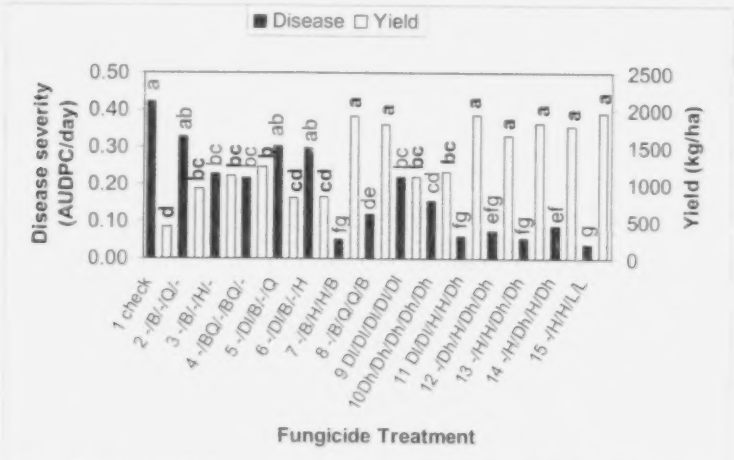

Figure 14. Ascochyta blight severity and yield of 2002 field plots of CDC Yuma (kabuli) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Ascochyta infection in CDC Yuma seed was 44% in control plots. Seed infection was reduced by treatments including two Headline applications in sequence with other products (7, 11, 13, 14, 15) or two Quadris applications in sequence with Bravo (7), and by a Bravo application at pre-flower and Headline at mid-flower (3). Other treatments had no effect on seed infection (Fig. 15).

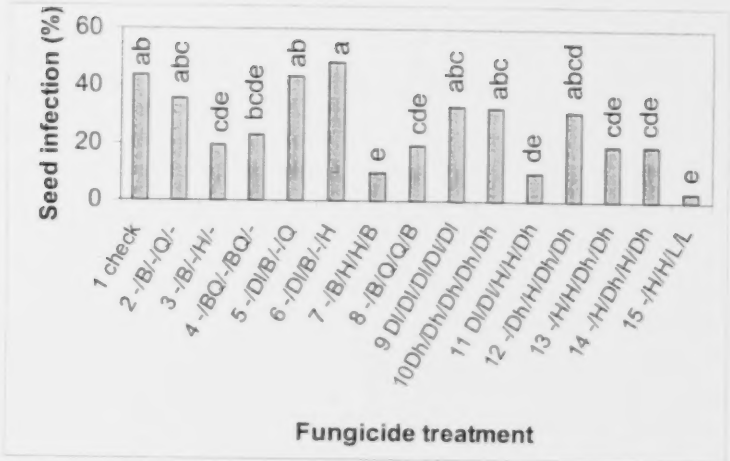

Figure 15. Ascochyta seed infection from 2002 field plots of CDC Yuma (kabuli) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different.

2003 Season

Due to dry conditions at Swift Current in 2003, disease severity was very low; 4% in Myles control plots and 6% in CDC Yuma control plots. In Myles, despite the low disease pressure, Treatments 4 (Bravo-Quadris tank mix at pre- and mid-flower), 13, 14 and 15 (all with two applications of Headline in combination with Dithane-high rate or with Lance), reduced disease development relative to the control (Fig. 16).

In CDC Yuma, an effect of several fungicide treatments on disease development could be detected. These included Dithane treatments (9, 10), combination Dithane and Headline treatments (11-14), Bravo-Quadris tank mix treatments (4), and a sequence of Dithane, Bravo, and Headline (6). All other treatments had disease levels equal to that of the control (Fig. 17).

There were no differences with respect to yield (Figs. 16, 17) or seed weight of either cultivar at Swift Current in 2003. Seed infection levels were close to zero in all treatments of both cultivars (not shown).

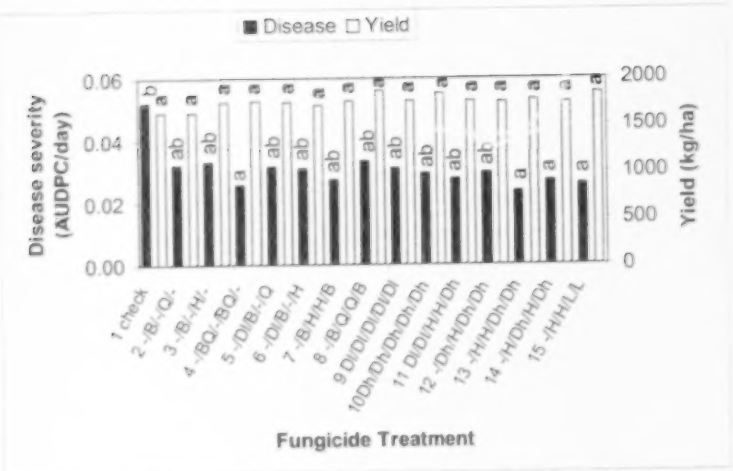

Figure 16. Ascochyta blight severity and yield of 2003 field plots of Myles (desi) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

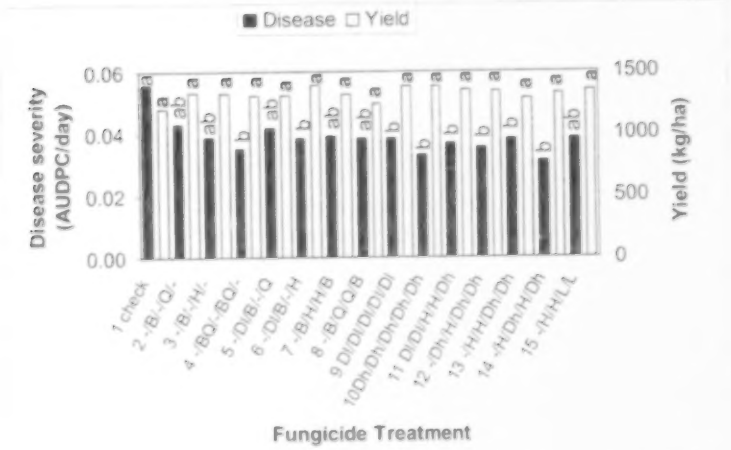

Figure 17. Ascochyta blight severity and yield of 2003 field plots of CDC Yuma (kabuli) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L).

Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

At Saskatoon in 2003, disease developed to moderate levels in both cultivars. On Myles, control plots had 33% disease severity. Most of the fungicide treatments reduced disease development, except for Treatments 5 and 6, both of which were a sequence of Dithane (low rate) at pre-flower, followed by Bravo at early flower and a strobilurin fungicide (Quadris or Headline) at late flower. Yield was unaffected by fungicide treatments 5 and 6, whereas other fungicide treatments increased yield by 36-60% over the control (Fig. 18). Linear contrasts showed that Treatment 9, (five applications of Dithane at the low rate) had higher disease than treatments using Dithane at the high rate, or Dithane in combination with Headline (Treatments 10, 11) (P=0.03). Treatment 10, which used only Dithane at the high rate, had higher disease levels and lower yield than Treatment 11, which used Dithane in combination with Headline (P=0.03 for disease, P=0.002 for yield).

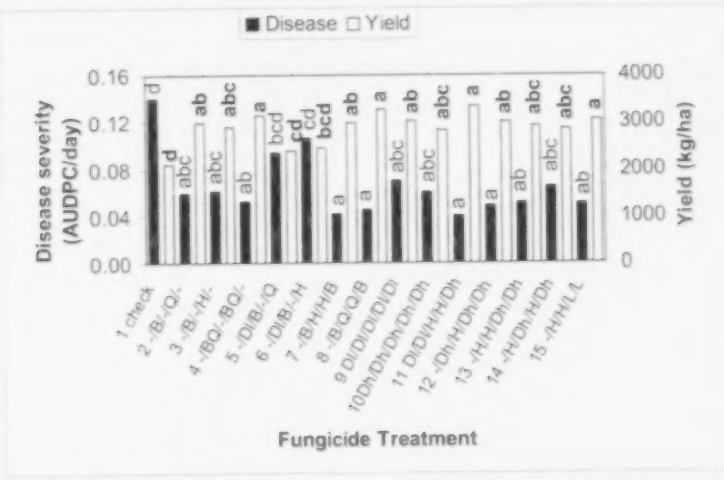

Figure 18. Ascochyta blight severity and yield of 2003 field plots of Myles (desi) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Several treatments increased the seed weight of Myles relative to the control. These included Bravo at pre-flower and Headline at mid-flower (3), sequences of Dithane and Headline (11-14), calendar sprays with Dithane at the high rate (10), and sequences with two applications of a strobilurin (7, 8). Seed infection levels were very low (<4%), so no effect of fungicide treatment on seed infection could be observed (Fig. 19).

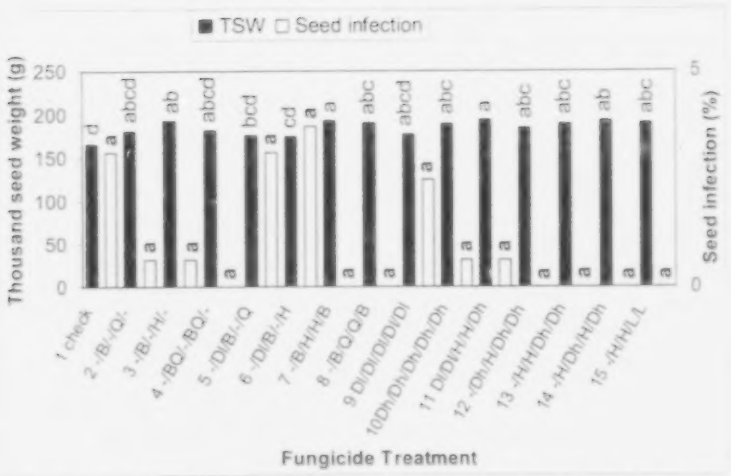

Figure 19. Seed weight and ascochyta infection of seed from 2003 field plots of Myles (desi) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

No significant differences in disease development were observed among fungicide sequences in CDC Yuma. All treatments reduced disease severity compared to the control plots, which had 39% disease severity. None of the fungicide treatments increased yield over the control, and all seed weights were equal to that of the control (Fig. 20). Seed weight was, however, lower in Treatment 10 (five applications of Dithane-high rate) than in Treatments 2, 4 (Bravo and Quadris in sequence or as a tank mix) or Treatment 11 (five applications of Dithane-low rate). Seed infection levels were low (<13%), and fungicide treatment had no effect on seed infection (Fig. 21).

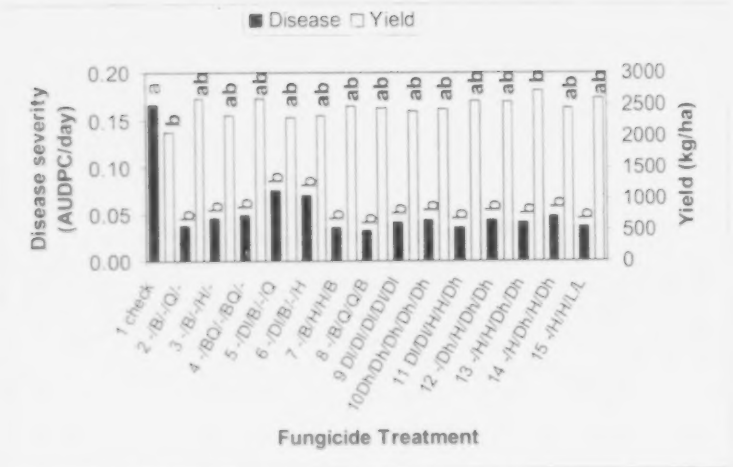

Figure 20. Ascochyta blight severity and yield of 2003 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

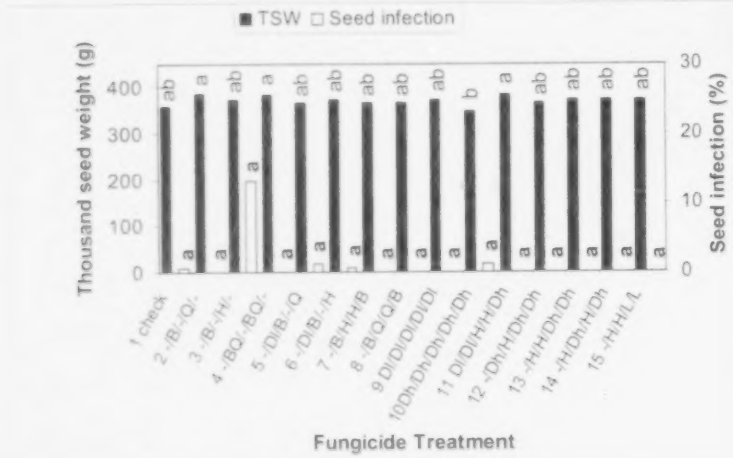

Figure 21. Seed weight and ascochyta infection of seed from 2003 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

2004 Season

Disease severity was moderate in plots of Myles at Swift Current in 2004, reaching 32% in control plots. Several treatments reduced disease development relative to the control, including treatments 4, 7, 8, 11, 13, and 15. These treatments all had two applications of a strobilurin fungicide (Headline or Quadris), or two applications of the Bravo-Quadris tank mix. Treatment 14, which also had two applications of Headline, had disease levels equivalent to that in control plots (Fig. 22). Linear contrasts were used to show that using Dithane alone at the high rate (Treatment 10) was less effective at controlling the disease than using Dithane in combination with Headline (Treatment 11) (P=0.03). There was, however, no difference in the yield of these treatments (P=0.9). All of the fungicide treatments resulted in improved yield compared to the control, except for Treatments 5 and 6, which consist of a pre-flower application of Dithane (low rate), followed by Bravo at early flower and Quadris or Headline at late flower (Fig. 22).

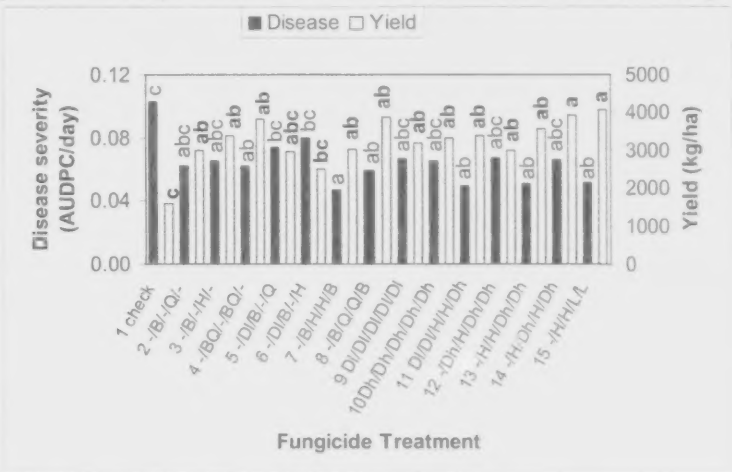

Figure 22. Ascochyta blight severity and yield of 2004 field plots of Myles (desi) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Seed weight of Myles from Swift Current was higher in Treatments 4, 8, 11, 14, and 15 than in the control. These treatments are among those that utilized two applications of Headline during the season. Myles seed infection (38% in the control) was significantly reduced by all of the fungicide treatments, but the treatments did not differ from one another (Fig. 23).

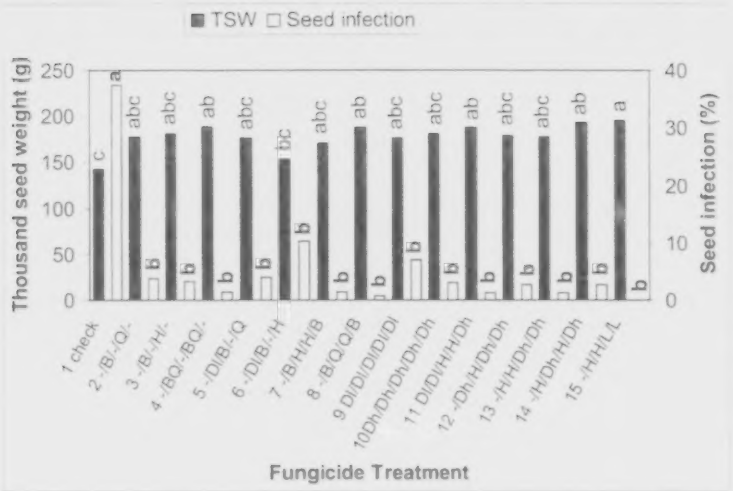

Figure 23. Seed weight and ascochyta infection of seed from 2004 field plots of Myles (desi) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

In plots of CDC Yuma at Swift Current in 2004, high levels of ascochyta infection were observed (91% in control plots). All of the fungicide sequence treatments reduced disease development relative to the control, except for Treatment 6 (Dithane-low rate at pre-flower, Bravo at early flower, Headline at late flower). Despite high disease pressure, fungicide treatments (except for Treatment 6) did not give different levels of disease control. Yield improvements were achieved by most treatments. Yields of Treatments 2 and 3 (two applications) and Treatments 5 and 6 (Dithane-low rate at pre-flower, followed by Bravo and strobilurin) were equivalent to the untreated control (Fig. 24). Lower yields resulted from repeated sprays of Dithane (low rate) than from using Dithane at a high rate, or using Dithane in combination with Headline (P=0.01).

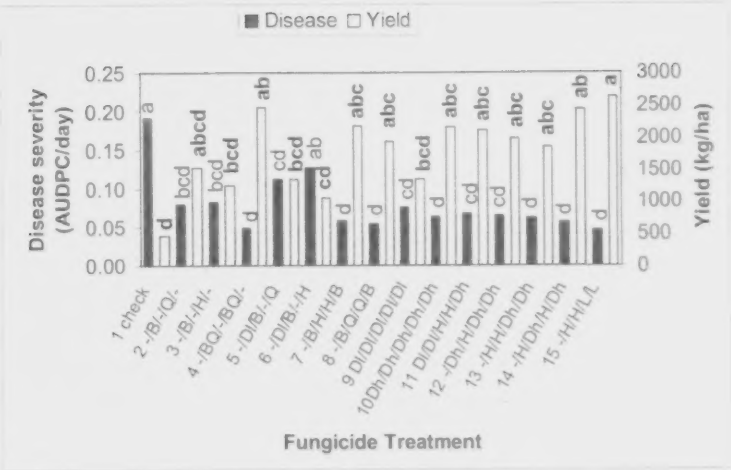

Figure 24. Ascochyta blight severity and yield of 2004 field plots of CDC Yuma (kabuli) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Seed weights of CDC Yuma from Swift Current were increased by most fungicide treatments, except for Treatments 5 and 6, which also had low yields. Seed from control plots had 41% ascochyta seed infection, and comparable levels were observed from many of the fungicide treated plots. Treatments 4, 7, 8, 10, 13, 14, and 15, all of which had high yields, significantly reduced seed infection (Fig. 25). These treatments were among those utilizing two applications of strobilurin during the season, and also included the repeated application of Dithane at the high rate.

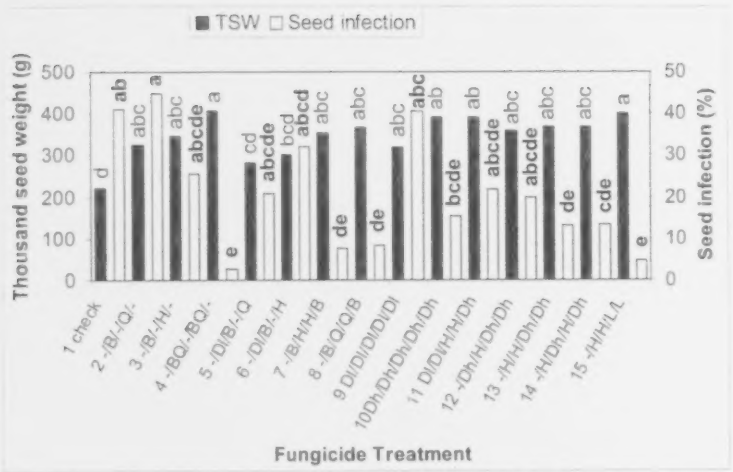

Figure 25. Seed weight and ascochyta infection of seed from 2004 field plots of CDC Yuma (kabuli) chickpea at Swift Current to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Disease development at Saskatoon in 2004 was slow, due to a cool season, but reached high levels (59% in Myles, 98% in CDC Yuma) by the end of the season. In Myles plots, all fungicide treatments reduced disease development, except for Treatment 5, which also performed poorly in several other trials (Fig. 26). Repeated applications of Dithane (low rate) gave higher disease levels than when Dithane was used at the high rate or in combination with Headline, as shown by contrasts (P=0.008). The use of Dithane in combination with Headline was more effective at controlling disease than using Dithane alone at the high rate (P=0.02). Despite high disease pressure, fungicide treatments had no effect on yield or seed weight of Myles (Fig. 26, 27). Seed infection levels were very high (71% in control plots), and all treatments reduced seed infection except for Treatment 9 (five applications of Dithane at low rate). In addition, using repeated applications of Dithane at the high rate resulted in higher seed infection rates than using Dithane in combination with Headline (Fig. 27).

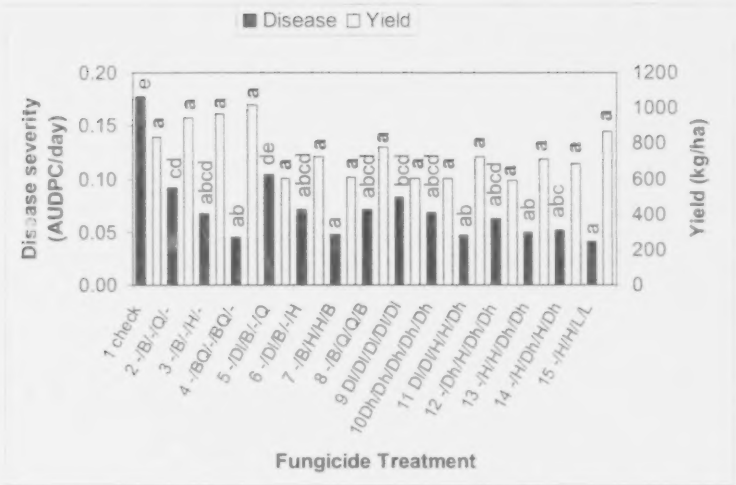

Figure 26. Ascochyta blight severity and yield of 2004 field plots of Myles (desi) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

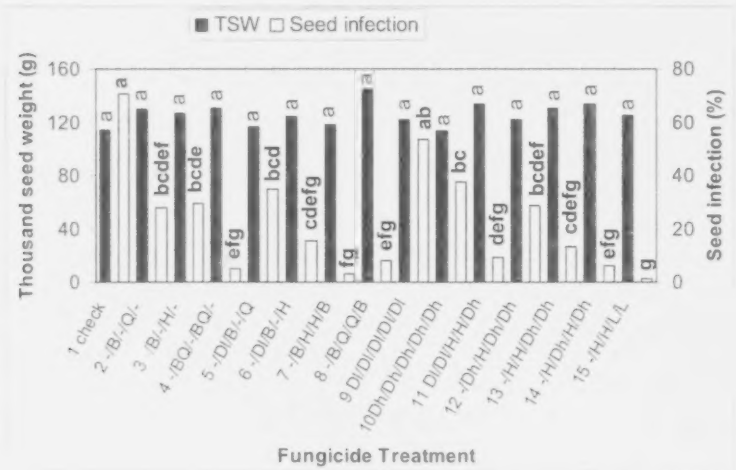

Figure 27. Seed weight and ascochyta infection of seed from 2004 field plots of Myles (desi) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Under the high disease pressure observed at Saskatoon on CDC Yuma in 2004, all of the fungicide treatments reduced disease development relative to the control, except for Treatment 2 (Bravo at pre-flower, Quadris at mid-flower). Remaining fungicide treatments were indistinguishable from each other, although some were superior to Treatment 2. Differences among the Dithane alone and Dithane-Headline treatments detected by linear contrasts for Myles were not observed for CDC Yuma. As for Myles, there was no effect of fungicide treatment on yield of CDC Yuma (Fig. 28).

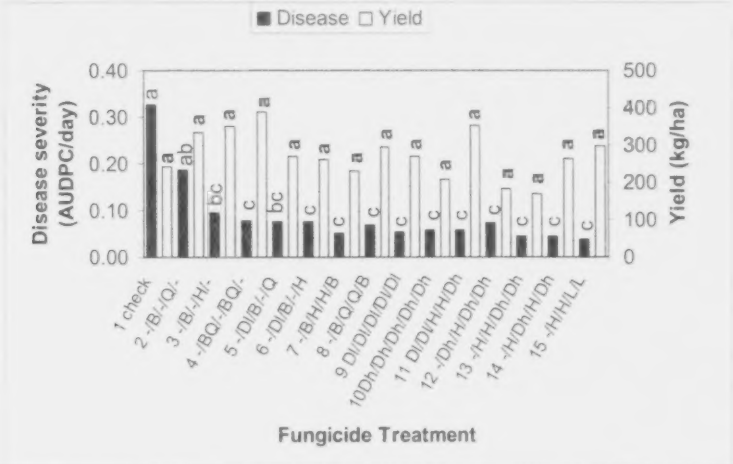

Figure 28. Ascochyta blight severity and yield of 2004 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Disease severity measured as area under the disease progress curve (AUDPC) per day of rating. Bars labeled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

None of the fungicide treatments resulted in increased seed weight of CDC Yuma relative to the control. Seed weight was, however, higher in Treatment 15 (two Headline and two Lance applications) than in Treatment 2 (one Bravo and one Quadris application). Ascochyta infection of seed was 52% in the untreated control. Only Treatments 2 and 9 (five Dithane applications at low rate) failed to reduce seed infection levels. Remaining fungicide treatments had equivalent seed infection rates to one another (Fig. 29).

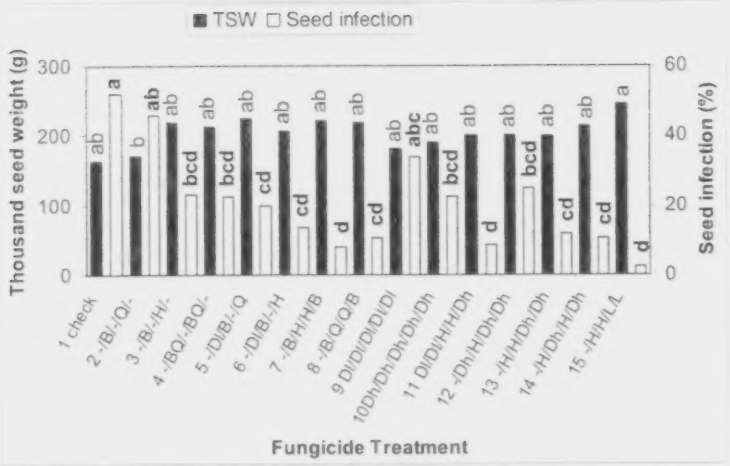

Figure 29. Seed weight and ascochyta infection of seed from 2004 field plots of CDC Yuma (kabuli) chickpea at Saskatoon to evaluate different sequences of fungicide products applied at seedling stage/pre-/early/mid/late flower with Bravo (B), Quadris (Q), Bravo-Quadris tank-mix (BQ), Dithane low rate (Dl), Dithane high rate (Dh), Headline (H) or Lance (L). Bars labelled with the same letter are not significantly different. Letters in bold type cannot be compared with letters in regular type.

Conclusions:

A wide range of disease pressure was observed over the three seasons of field studies. Experiment 1 (fungicide timing) demonstrated that pre-flower application of fungicide was critical for reducing disease development over a wide range of disease pressure levels. Due to severe drought conditions, yield data from this trial was limited, and so the impact of pre-flower fungicide application on yield was more difficult to assess. In two of four cases where data was available, however, pre-flower application lead to higher yields than where no pre-flower application was made. This experiment also showed that three applications were better than two applications for disease control and/or yield protection. Three applications were superior to two applications even under the low disease pressure observed at Elrose on Myles in 2002, but the effect on yield could not be assessed. At moderate and at high disease pressure, Treatments 2 (single Bravo application) and/or Treatment 5 (Bravo at early and mid-flower; no pre-flower application) performed poorly in terms of disease control and in yield of Myles plots at Saskatoon in 2003. Treatment 4 (Bravo at pre-flower and late flower) was also ineffective for disease control at high disease pressure. General trends were difficult to discern for seed weight and infection, since data was only available for some site-years. Recommendations to producers are to scout fields for disease very early in the season, and to consider fungicide application prior to flowering as a preventative measure if wet weather is forecasted.

In Experiment 2 (fungicide sequencing), there were few differences among treatments under low disease pressure. At moderate and at high disease pressure, Treatments 5 and 6 (Dithane-low rate at pre-flower, Bravo at early flower, Quadris or Headline at late flower) had higher disease levels and lower yields than other treatments. At high disease pressure, these treatments also had lower seed weights and higher seed infection levels than other treatments. Under moderate disease pressure observed at Swift Current in 2004 on Myles, the use of two strobilurin products (Headline or Quadris) or two applications of a Bravo-Quadris tank-mix, gave good disease control and higher seed weights. In some cases where disease pressure was high, treatments using two strobilurin applications resulted in good disease control and/or low seed infection rates. At both moderate and high disease pressures, five applications of Dithane at the low rate was not as effective as using Dithane at a high rate, or in combination with Headline. In several cases, using Dithane alone at the high rate was not as effective as using Dithane in combination with Headline. At high disease pressures, there were two cases where using five applications of Dithane at a low rate resulted in high seed infection levels. Application of Bravo at pre-flower and Quadris at mid-flower (Treatment 2) when disease pressure was high resulted in high disease levels and low yields.

References:

Vail, S., Chongo, G., and Banniza, S. 2004. Pathogenic variability of *Ascochyta rabiei* populations on chickpea in Saskatchewan. Can. J. Plant Pathol. 26(2): 229 (Abstr.).

Papers/Presentations:

Scientific manuscripts for publication in refereed journals will be prepared and submitted in the next months.

Banniza, S. 2005: Disease issues in 2005. Presentations at the Saskatchewan Variety Release Program winter meeting, Saskatoon, Jan 14, 2005

Banniza, S 2004: Pulse Crop Production in Saskatchewan. Presentation at the Crop Management Forum of the Canadian Association of Agri-Retailers, Saskatoon, Nov 18, 2004

Armstrong-Cho, C., Chongo, G., Gan, Y., Wolf, T., and Banniza, S. 2004. Fungicide application timing for management of ascochyta blight in chickpea. Soils and Crops 2004. Extension Division, University of Saskatchewan (Saskatoon).

Chongo, G., Banniza, S., Gan, Y., Wolf, T. and Warkentin, T. 2003: Fungicides application timing, sequencing and tank mixes for controlling blight in chickpea. Soils and Crops 2003. Extension Division, University of Saskatchewan (Saskatoon).

Banniza, S. 2004: Update on disease issues in pulse crops. Saskatchewan Pulse meetings 2004, 3-6 February, Rosetown, Swift Current, Assiniboia, Regina.

Banniza, S. 2004: Disease update from 2003 and the forecast for 2004. Crop Science Life Canada – SK Council, Saskatoon, 22 January 2004.

Banniza, S. 2004: Disease issues in pulse crops. Saskatchewan Select Growers Day, Saskatoon, 14 January 2004.

Banniza, S. 2003: Update on the pulse crop pathology research program. SAFRR Research updates, Saskatoon, 14 December 2003.

Banniza, S. 2003: Ascochyta blight in pulse crops. Indian Head Zero Till Field Day, 22 July 2003

Banniza, S. 2003: Research issues in pulse pathology. Pulse Information Meeting, Outlook, January 26, 2003.

Chongo, G., Banniza, S., Gan, Y., Wolf, T. and T. Warkentin 2003: Fungicide application timing, sequencing, and tank mixes for controlling blight in chickpea. [Poster Abstract] Pulse Days 2003, Saskatoon, January 6-7, 2003, p. 84

Banniza, S. 2002: Ascochyta blight in pulse crops. Indian Head Zero Till Field Day, July 23, 2002.

Banniza, S. 2002: Pulse diseases. Select Grower Field Day, July 26, 2002.

Future Research:

Research on ascochyta blight management in chickpea has been continued at AAFC Swift Current in close collaboration with us.

Information of benefit to producers, processors, or governments:
Results from this research have been and will continue to be presented at various extension meetings with producers. Results have also been incorporated in the CD produced by SAFRR and designed for chickpea producers called 'Management of ascochyta blight of chickpea in Saskatchewan' that summarizes the newest research results and provides guidelines on how to approach ascochyta blight management in chickpea. This CD was based on meetings of the Chickpea Ascochyta Blight Response Team Meetings that have been organised annually through Penny Pearse, the provincial disease specialist and that brought together scientist, agrologist and representatives of the agro-chemical industry to discuss and update strategies in chickpea ascochyta blight management.

(d) Personnel: Dr. Godfrey Chongo managed the project until his departure from the University in May 2003. Ms. Cheryl Armstrong-Cho assumed responsibility for the field work in 2002, and managed the project after Dr. Chongo's departure.

(e) Equipment:
None

(f) Project Developed Materials:
None at this stage

(g) Project Photos:
CD with pictures can be provided on request.

(h) Acknowledgement:

The Saskatchewan Agricultural Development Fund has been acknowledged in all presentations where this research project was mentioned.